supply the fastening to the other. Then substitute for the fluid flowing round the circuit of the pipe, a flexible chain, running in the same path. In this case the centrifugal forces of the chain running in its curved path are similar to those of the fluid flowing in the pipe; and the longitudinal tension of the chain represents in every particular the longitudinal tension on the pipe.

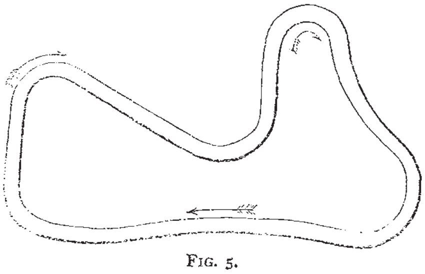

FIG. 5.

As a simple form of this experiment, if a chain be set rotating at a very high velocity over a pulley in the manner shown in Fig 6, it will be seen that the centrifugal forces do not tend to disturb the path of the running chain; and, indeed, the velocity being extremely great, the forces, in fact, tend to preserve the path of the chain in opposition to any disturbing cause. On the other hand, if by sufficient force we disturb it from its path, it tends to retain the new figure which has been thus imposed upon it (see Fig. 7).

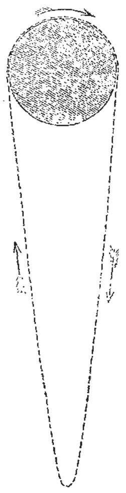

FIG. 6.

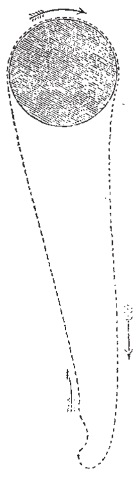

FIG. 7.

The apparatus with which I am about to verify this proposition has been lent to me by Sir W. Thomson. It is one which he has used on many occasions for the same purpose; and I must add that the proposition in his hands has formed the basis of conclusions incomparably deeper and more important than those to which I am now directing your attention.

You observe the chain when at rest hangs in the ordinary catenary form, from a large pulley with a very wide-mouthed groove and mounted in a frame which is secured to the ceiling. By a simple arrangement of multiplying bands the pulley is driven at a high speed, carrying the chain round by the frictional adhesion of its upper semi-circumference. When at its highest speed the chain travels about 40 per second.

The idea that the chain when thus put in motion will be disturbed by its centrifugal force from the shape it holds while at rest must point to one of two conclusions; either (1) the chain will tend to open out into a complete circle, or (2) it will on the contrary tend to stretch itself at its lower bend to a curvature of infinite sharpness.

But you observe that no tendency to either change of form appears. On the contrary, the chain, instead of taking spontaneously any new form in virtue of its centrifugal force, has plainly assumed a condition under which it is with difficulty disturbed, alike from its existing form, or from any other which I communicate to it by violently striking it. Such blows locally indent it almost as they would bend a bar of lead.

In spite, however, of this quasi-rigidity which its velocity has imparted to it, it does, if left to itself, slowly assume, as you perceive, a curious little contortion, both as it approaches and as it recedes from the lower bend of the catenary; and it is both interesting and instructive to trace the cause of the deformation.

I have already explained that the speed of the chain subjects it throughout to longitudinal tension. Speaking quantitatively, the tension is equal to the weight of a length of the chain twice the height due to the velocity. This is $\frac{v^2}{g}$, and thus, as the speed is 40 feet per second, $\frac{1600}{32} = 50$ feet, or with this chain about 14 lbs.

Now in travelling through the lower bend of the catenary, the chain passes from being nearly straight, to being sharply curved and immediately straightened again, and this change of form involves a continued pivoting of link within link, the friction being called into action by the tension which presses the surfaces together. Each link thus in succession resists this pivoting with a definite force, and the resistance, in effect, converts what appears to be a perfectly flexible combination into one possessing a tangible degree of stiffness, and the oblique attitude assumed by the chain as it approaches the bend, and the slight back turn which it assumes as it emerges from the bend, are alike consequences of this factitious stiffness.

For in virtue of gravity, the running chain, like the chain at rest, tends always to maintain the original catenary; and in virtue of its speed of rotation, it seeks to maintain (not preferentially the catenary, but) whatever form it for the moment possesses. Hence its departure from the true catenary was, as you saw, gradual. But when the figure of equilibrium is once attained, the persistency of form imparted by velocity serves to maintain this figure as indifferently as any other. Hence the figure is that in which equilibrium subsists between the force of gravity seeking to restore the catenary, and the factitious stiffness resisting the necessity of bending and unbending.

The slowness with which the form is assumed, and its steady persistency when once assumed, alike bear witness to the truth of the proposition which it is the object of the experiment to verify.

The stream of fluid in the tortuous flexible pipe would behave in a strictly analogous manner.

(*To be continued.*)

NOTES

IT is with great regret that we hear of the death of Dr. von Willemöes-Suhm, the distinguished naturalist assisting Prof. Wyville Thomson in the *Challenger*. Information of the sad occurrence has just been received at the Admiralty.

AT the opening meeting of the Royal Geographical Society on Monday, the president, Sir H. Rawlinson, reviewed the progress of the Society and of geographical discovery during the past year. He announced that the Prince of Wales, the Vice-patron of the Society, had just sent the Society, as the first geographical result of his tour in the East, a very interesting collection of route-maps of Upper Egypt and its recently acquired dependencies, which had been executed in the Topographical Department of the Egyptian War Office by General Stone, Chief of the Etat Major, from materials furnished in one direction by Col. Gordon and the officers serving under his orders, and in another by Col. Purdy and the officers of the Darfur Expedition. These maps contain much new geographical matter. The President referred with great satisfaction to Stanley's exploration of the Nyanza, and exhibited a complete chart of the lake drawn by Stanley. As to Col. Gordon, who by last accounts had reached Appudo, 140 miles from the Albert Nyanza, if he could overcome the eight miles of rapids which lay before him, he would probably reach the Albert Nyanza with his steamer the *Khedive*, before Stanley. Both Gordon and his assistant Chipendall report, from native information, that the Nile leaves the Albert Nyanza by two channels. Dr. Pogge and Dr. Lasaulx, the only remaining members of the German African expedition, have shifted their ground to the south, with the intention of starting from the Loanda base, and making their way *viâ* Cassange to the mysterious capital of Matiamno. The President then referred to Capt. Trotter's work on the Panjah River, and to the Russian scientific expedition to Hissar, by which we are now able to construct a reliable map of the country between the Upper Oxus and Jaxartes. Sir Henry then spoke of New Guinea, and of the failure of Macleay's expedition. D'Albertis has during the late spring and summer been occupied in natural history researches on Yule Island, while the Rev. S. Macfarlane and Mr. Stone have discovered and ascended for a distance of sixty miles a large river on the south coast of New Guinea. The river is from one to a quarter mile broad, and from three to twelve fathoms deep, and might easily be made navigable for more than 100 miles. It is proposed to call it the Baxter River. At the close of his address, the President observed that at the next meeting the subject of the Victoria Nyanza will be fully gone into, and that the discussion on that subject had better therefore be reserved until that occasion. Mr. W. L. Watts afterwards read a paper on his journey last summer across the Vatna Jökull, Iceland.

THE *Daily Telegraph* of Monday contains Mr. Stanley's letter which was sent home by the unfortunate Col. Linant de Bellefonds. It is dated "Mtesa's Capital, Uganda, April 12," and is principally occupied with an account of Mr. Stanley's voyage round the southern, eastern, and north-eastern shores of the Victoria Nyanza. His exploration has evidently been made with great care, and he has ascertained with considerable certainty that Speke was right in regarding the Nyanza as only one lake. It is, however, evidently thickly studded with islands, and its coast much broken up into bays and creeks by long promontories from the land. Stanley was most hospitably received and magnificently entertained by Mtesa, who, since Speke saw him, has, with his people, turned Mahommedan. Stanley speaks of him with the greatest respect, and believes that he might be made a most effective instrument for the civilisation of the region surrounding his capital. The *Telegraph* of Tuesday contains Mr. Stanley's map of the Nyanza, neatly reproduced.

MR. JAMES STUART, Fellow of Trinity College, has been elected Professor of Mechanism and Applied Mechanics at Cambridge University.

WE understand that the Council of the Scottish Meteorological Society have resolved to commence an investigation into the habits of the salmon. The point which is first to be investigated is the question of the earliness or lateness of the different rivers, and for this purpose they have entered into communication with Mr. Archibald Young, Fishery Commissioner, at whose suggestion various early and late rivers have been selected, and arrangements have already now been made for carrying on the necessary observations on the river Ugie, Aberdeenshire.

WE have received six large temperature and rain charts of the United States, constructed by Mr. Charles A. Schott from observations collected by the Smithsonian Institution, which show by lines the distribution of temperature for every 4° from 36° to 76°, and of rainfall for every two or four inches during summer, winter, and the year. The principle on which the temperature charts have been constructed, and which was fully described in NATURE in reviewing the annual chart in the small form in which it was first published, consists in representing actual mean temperatures, uncorrected for elevation. The whole form a set of six charts illustrative of the most prominent features of the climatology of the United States, and are calculated to prove of great utility in many practical matters.

THE Report of the Commission appointed by the Prussian Government for the scientific investigation of the Baltic and North Sea, for 1872 and 1873, has just been published. The Report (pp. 380), which is a very valuable one and well illustrated, contains discussions on the fisheries of the German coasts, by Dr. V. Hensen; and on the physical observations made at the various stations of the Commission, by Dr. G. Karsten; together with interesting papers by Dr. H. A. Meyer, Dr. P. Magnus, Dr. K. Möbius, and others, on the currents, temperature, and specific gravity of the sea, and on the botanical and geological results of the expedition which was undertaken during the summer of 1872 with the view of collecting data bearing on the physics, chemistry, and biology of the North Sea. We hope to examine this at length in an early number.

DR. BURMEISTER, Director of the National Museum of Buenos Ayres, has in course of preparation a complete scientific description of the Argentine Republic. The first volume, containing the history and geography, is already in the press. The second, containing the meteorology, physical geography, and biology, is in preparation. The work is in German, but the Argentine Government has undertaken a French translation of it.

DR. BURMEISTER has also nearly ready a description of a complete skeleton of the Fossil Horse of Buenos Ayres (*Hippidium neogaeum*, Owen), of which but fragmentary portions have been previously known.

AN important work on the Zoology of Eastern Asia will appear in Russia before the close of the current year. It will comprise the results of the journey undertaken by Colonel Przevalski in Western China, and it will include descriptions of many new and interesting species. It is not improbable that a translation will be published in English.

WE would draw the attention of our biological readers to Mr. G. E. Dobson's valuable Conspectus of the sub-order, families, and genera of Cheiroptera, arranged according to their natural affinities, in the "Annals and Magazine of Natural History" for this month.

WE have received Prof. Cope's systematic catalogue of Vertebrata of the Eocene of New Mexico collected in 1874, containing the account of forty-seven species, of which twenty-four are described for the first time. The genera *Bathmodon* and *Uintatherium* are placed in a new order—Amblipoda—by themselves, and the foot of the former is figured, with three phalanges to the hallux, which is evidently inaccurate.

WE have also received a paper by Prof. O. C. Marsh, on the *Odontornithes*, or birds with teeth, containing illustrations of parts of *Ichthyornis dispar* and *Hesperornis regalis*.

MR. W. H. DALL, of the U. S. Coast Survey, has published the results of his examination of Mount Saint Elias, Mount Fairweather, and other peaks of the range which skirts the coast of the narrow strip in the south of Alaska; Mount St. Elias, however, really seems to be in British territory. Very various heights have been given to the latter from La Pérouse downwards, varying from 12,600 to 17,800 feet, the British Admiralty Chart making it 14,970 feet. Mr. Dall, from many careful observations, gives the height as 19,500 feet, with a possible error either way of 400 feet. Mount Fairweather he gives as 15,500 feet; Mount Crillon, 15,900 feet, with possible error of 500 feet; Mount Cook, 16,000 feet; Mount Vancouver, 13,100 feet; and Mount La Pérouse, 11,300 feet, the last three being approximate. The names of Cook and Vancouver have been given by Mr. Dall to two high peaks of the St. Elias range to the southward and eastward of St. Elias; to a high peak near the sea, at Icy Cape, he has given the name of La Pérouse; Mount Crillon is to the south of Mount Fairweather. The following are the geological conclusions at which Mr. Dall arrives with regard to this range:—That these Alps are, like the high Sierra of California, mainly composed of crystalline rocks, and in their topography, their small, pustular, basaltic vents, their associated marbles, quartzites, and later conglomerates, exhibit a close parallel to the Sierras; that parallelism in structure and composition implies parallelism in age and method of formation; and, finally, that the volcanic origin of the high peaks is opposed not only by analogy, but by the known facts." An examination of the clear sketches certainly seems to bear out Mr. Dall's conclusion that these peaks are not of the volcanic type.

LONDON has at last come in for her share of the disasters by flooding which have devastated so many river valleys in England and on the Continent. An unprecedentedly high tide caused the Thames to overflow its banks on the south side very early on Monday morning, flooding the streets and houses of Lambeth and other low-lying districts all along that side of the river, from Woolwich even to Kingston, we believe. The damage caused has been very serious and extensive, several feet of water rushing at one time through many streets on the south side, even at a considerable distance from the river. No one seems to have expected an unusual tide, though in March last year a similar phenomenon was looked for; the tide then, however, was seven inches lower than that of Monday. It is supposed that a very high spring tide with a strong gale blowing is the cause of the disaster.

THE force of the last hurricane in Paris was so great that its maximum could not be measured at the Montsouris Observatory, the magnetic anemometer having been broken by the rush of wind. The rate measured by Robinson's cups exceeded 70 kilometres per hour, when the apparatus was put out of order by the excess of central force.

MR. WILLIAM SANDERS, a well-known geologist in the West of England, died on Friday at his residence at Clifton, aged 76.

A COURSE of twelve lectures, by Mr. E. Bellamy, on the Anatomy of the Human Form, commenced last Monday, in connection with the National Art Training School, South Kensington. There are to be twelve lectures in all, to be delivered on Monday evenings.

WITH reference to the subject of the use of the movements of the sea as motive powers, referred to in NATURE, vol. xii. p. 212, Señor Don Eduardo Benot writes that the subject has been a study with him for many years, and he will be pleased to correspond with anyone who may wish to obtain information on the subject. Señor Benot's address is Barquillo 5, Madrid, Spain.

ACCORDING to a report presented by Count Hallez d'Arros to the Managing Committee, the Exhibition of Electrical Appliances, to be held at Paris in 1877, will be divided into the following groups:—1. History of Electricity; 2. Apparatus for Demonstration; 3. Piles and Batteries; 4. Electro-magnetism; 5. The Electric Telegraph; 6. The Electric Light; 7. Electric Motors; 8. Electrotyping; 9. Therapeutic Electricity.

A CORRESPONDENT at Belfast has sent us specimens of the caterpillar of *Arctia caja*, telling us at the same time that during this season, in which they have been particularly numerous, he has noticed that they have done much injury to textile fabrics laid on grass to bleach, by perforating them in circular holes, specially during sunshine after rain. The holes they make vary in size, some being very small, others large enough to admit the body of the animal. They are usually in clusters, and each is generally surrounded by a greenish coloured matter, apparently ejected by the caterpillar. This habit of *Arctia caja* is quite new to entomologists.

WE have received in a separate form, reprinted from the report of Major J. W. Powell's Exploration of the Colorado River of the West and its tributaries, a lengthy paper by Dr. Elliott Coues on the North American cheek-pouched rodent genera *Geomys* and *Thomomys*. The number of species of the former is given as five; of the latter two, of which one, *T. clausius*, is new, and is figured life size.

THE French Minister of Marine is establishing at the Depot of Maps, a new office for meteorology, which will be in some respects in connection with the Meteorological Office of the National Observatory. It will be placed under the control of Capt. Mouchez.

THE numerous reports as to the occurrence of a remarkable marine animal on the coast of New England during the past summer have induced the Boston Society of Natural History to prepare and distribute a circular calling for information on the subject.

IN a Congregation held at Oxford on Nov. 10, Prof. Bartholomew Price, Warren De la Rue, D.C.L., John Dale, M.A., and William Esson, M.A., were duly appointed visitors of the University Observatory. This is the first appointment of such visitors. The Observatory, which has been lately completed, took its rise, as our readers know, in the munificence of Dr. De la Rue.

MR. GEORGE SMITH, of the British Museum, left London last week for the East, to resume his researches in Assyria. He will be absent six months.

MESSRS. W. and A. K. Johnston have published a very clear map of India, to illustrate the travels of the Prince of Wales. It is on the satisfactory scale of seventeen miles to an inch, is fairly full but not too crowded with names, and has the proposed route of his Royal Highness clearly shown. Of course the route is liable to be altered, but anyone will be able to follow the Prince in the map without effort. Side by side with the principal map is a neat map of England on the same scale, showing at once the comparative sizes, and the fact that our country is only about twice the size of Ceylon. There is also a map of part of Europe, Asia, and Africa, showing the route from England to India. The blue surface of the wide Bay of Bengal has been utilised for a number of useful statistics concerning India. Anyone interested in following the Prince's route will find this map of great service.

THE success of the geographical play "Round the World in Eighty Days" has encouraged another Paris theatre to try an astronomical drama under the title of "Travels in the Moon." But the only astronomical part of the performance is a large moon which is exhibited in front of the theatre, showing to an admiring crowd the principal features of Beer and Madler's well-known lunar map.

CAPTAIN SOUTER, of the *Intrepid*, from the Davis Straits whale fishing, reports that while anchored in Isabella Bay on the 13th August he found it necessary, in consequence of the great body of ice coming down, to proceed on shore. After sailing some distance he came into a fine commodious natural harbour, not marked in the charts. There was nothing to show that it had ever been entered before. Captain Souter and other officers left in a cairn a writing indicating the discovery. Splendid water was found.

THE additions to the Zoological Society's Gardens during the past week include a Beisa Antelope (*Oryx beisa*) from Central Africa, presented by the Seyyid Burgash of Zanzibar; two Central American Agoutis (*Dasyprocta punctata*) from Central America, presented by Capt. E. Hairby and Mr. W. J. Henderson respectively; a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr. John Jennings; a Spotted Ichneumon (*Herpestes auropunctatus*) from Nepal, presented by Mr. L. B. Lewis; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Master E. H. Cole; a Malbrouck Monkey (*Cercopithecus cynosurus*) from E. Africa, presented by Mr. C. L. Norris Newman; a Dufresne's Amazon (*Chrysotis dufresniana*) from S. E. Brazil, presented by the Rev. A. Hibbet; a Mona Monkey (*Cercopithecus mona*), a Campbell's Monkey (*Cercopithecus campbelli*) from W. Africa, deposited.